PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO RETAINING RINGS

(71) We, WALDES KOHINOOR INC., of 46—16 Austel Place, Long Island City, New York 11101, United States of America, a corporation organized and existing under the laws of the State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates generally to a retaining ring for insertion in a circumferential groove provided in the surface of a carrier member, such as a shaft or a housing bore, to form a shoulder for the retention or location of a machine-part, the shoulder projecting from the shaft periphery or from the housing-bore surface, as the case may be.

Known tapered retaining rings of both the external and internal forms, being characterised by a radial width decreasing gradually from a maximum at their mid-section to a minimum near open ends defining a ring gap, suffer from the disadvantage that, because their minimum radial width is small, the shoulder-providing areas of the ring body at or near its open ends are relatively small. Yet another disadvantage of the conventional tapered retaining ring is that its neutral diameter is limited, depending as it does on the maximum radial width of the ring; and the degree of expansion of which the conventional ring may be capable depends on the relationship of the neutral diameter, maximum radial width, maximum permissible bending stress in the ring material, and Young's modulus for the ring material.

While the aforementioned disadvantages, although everpresent, are sometimes held to be tolerable for straight or planar-faced (non-bevelled) rings, that cannot be said for tapered bevelled-face rings, which, when inserted in their shaft or housing-bore grooves, are intended to take up end-play.

According to the present invention, there is provided a retaining ring for insertion in a circumferential groove provided in the surface of a carrier member, such as a shaft or housing bore, to form a shoulder for the retention or location of a machine-part, the ring having an open-ended ring body comprising a plurality of alternately radially outwardly and radially inwardly directed portions each having a respective beam and common connecting arms extending divergently from and connecting the beams in series with one another, the beams of the radially outwardly directed portions having radial widths which decrease progressively from a line radially bisecting the middle portion of the ring body and the connecting arms being arranged to be so deflected on expansion or compression of the ring body as to displace adjacent beams circumferentially of the ring body.

Preferably, the beams of the radially outwardly directed portions comprise short-length arcuate outer-edge portions of the ring body, divergent ring-body arm portions extend inwardly from the outer edge portions, the beams of the radially inwardly directed portions comprise short-length arcuate inner-edge portions of the ring body, the inner edge portions are angularly displaced relative to the outer-edge portions, divergent ring-body arm portions extend outwardly from the inner edge portions, and the divergent arm portions connect each outer-edge portion to facing ends of each two adjacent inner-edge portions and each inner-edge portion to facing ends of each two adjacent outer-edge portions.

Embodiments of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a front elevation of an external retaining ring according to a first embodiment of the present invention;

Fig. 2 is a section on the vertical centre line 2—2 of Fig. 1;

Fig. 3 is a front elevation of an internal

retaining ring according to a second embodiment of the present invention;

Fig. 4 is a section on the vertical centre line (corresponding to line 2—2 of Fig. 2) of Fig. 3; and

Fig. 5 is a fragmentary detail view of a body portion of a ring embodying the present invention.

Referring now to the drawings, Figs. 1 and 2 illustrate an external tapered ring, with Fig. 2 additionally illustrating that the ring may also be provided with a bevel along its effective inner (groove-seating) edge. An open-ended ring body 10 comprises a plurality of short-length arcuate outer-edge portions, such as 12a, 12b and 12c (hereinafter referred to as outer-edge "beams"), which are circumferentially spaced by outer-edge cut-outs such as 14a, 14b and 14c, and a plurality of short-length arcuate inner-edge portions such as 16a and 16b (hereinafter referred to as inner-edge "beams"), which are circumferentially spaced by inner-edge cut-outs or recesses such as 18a, 18b and 18c. The inner-edge "beams" 16a, 16b etc., are angularaly staggered or non-radially disposed relative to the outer-edge "beams" 12a, 12b etc., and each outer-edge beam is supported by two divergent ring-body portions 20a and 20b, which extend inwardly to and connect with the circumferentially-spaced ends of adjacent inner-edge "beams".

Thus, the ring body may be said to comprise a plurality of serially-connected alternately radially outwardly and radially inwardly directed portions having common connecting arms.

The ring body 10 (Fig. 1), being of split or open-ended construction characterising the external-ring form, has a narrow-width gap 10g extending between and defining the ring ends, which illustratively are configured as apertured ears 24a, 24b, with or into the apertures of which the points of pliers or other suitable ring-spreading means may be coupled for ring insertion and extraction (in and from groove) purposes.

The illustrated retaining ring is a tapered ring, whose radial width, actual and effective, decreases progressively from maximum at the ring middle-section to minimum at sections near its ends. That is to say, the radial widths of the outer-edge "beams" 12a, 12b, etc., decrease progressively from maximum to minimum, just as to the radial widths of the inner edge beams 16a, 16b, etc.

The effective radial width of the ring, i.e. the radial width of the ring as measured from the outer edges of the outer-edge "beams" to the inner-edges of the inner-edge "beams", also decreases progressively from maximum at the ring middle section to minimum at sections near the ring ends, but the effective radial width, because of the provision of the connecting arms 20a and 20b, is, in the case of the ring of Fig. 1, approximately twice that of the conventional tapered retaining ring. This feature makes possible a tapered ring of substantially increased shoulder height, as compared to that of convention tapered rings, with reduced danger of the ring being excessively stressed or deflecting beyond allowable stress limits or—in the case of pre-stressed rings—of taking on a permanent set in the course of its being spread over a shaft during the insertion operation.

More particularly, considering that the exemplary ring shown in Fig. 1 has nine outer-edge "beam" neutral axes, each of a length determined by the angle α and eight inner-edge "beam" neutral axes, each of a length determined by angle β, the assumption can be made that, if these axes were added together, they would form a ring which would allow a deflection according to the stress formula:

$$\sigma = \frac{(d_1+2h)(d_2+2h)s}{h_{max.}\ E},$$

where

σ=deflection, i.e., shaft diameter minus free diameter d_1,

d_1=free diameter of the ring before it has been expanded,

d_2=free diameter of the ring after it has been expanded and allowed to spring back to its free state,

(d_1+2h)=the neutral diameter of the ring before it has been expanded,

(d_2+2h)=the neutral diameter of the ring after it has been expanded and allowed to spring back to its free state,

h=mean radial width of outer edge beams,

$h_{max.}$=maximum radial width of the outer edge beam at the ring middle section,

s=allowable bending stress, and

E=Young's Modulus.

In the above formula, and elsewhere in the specification, "free diameter" signifies the diameter of the inner circumference of the ring in its free state (i.e., when not expanded in use), and "neutral diameter" signifies a median diameter of the ring which is half the sum of the diameters of its inner and outer circumferences.

To increase the deflection σ, the ring portions are connected as described. There are 18 connecting members, each having a

neutral axis formed within the angle ν (Fig. 1). However, the axis of each connecting member is inclined relative to the radius R by the angle ε (Fig. 5). When the ring is opened in being spread over a shaft, each connecting member deflects by the angle ε_1, this deflection being determined by the length and width ω (Fig. 1) of the connecting members and by Young's modulus for the ring material. In the typical ring illustrated in Fig. 1, there are 18 such connecting members. Therefore the increase in deflection provided by this arrangement of connecting members is the sum of 18 angles ε_1, which is an amount allowing an increase of total deflection of the free diameter to 1.5σ in the case of the ring of Fig. 1, with σ being the permissible deflection of known tapered retaining rings.

Internal rings as illustratively shown in Fig. 3 and 4, will act in the same manner, albeit inversely. The number of connecting members and the radial widths of the ring bodies shown in Fig. 1 and 3 will be selected to correspond with known rings used for the same shaft or housing size. However, by varying the number and the width of the connecting arms 20a and 20b and the radial widths of the "beams" of the rings, tapered retaining rings having increased radial widths and deflecting capability can be made in many variations.

The ring thus far described, in both its external and internal forms, may be taken to be a flat or planar-faced ring, whereas it may also be and preferably is provided along its groove-seating edge with a bevel 30 which enables the ring, when inserted in its groove, to take up end play. More particularly, referring to Figs. 2 and 4, a bevel 30 is provided along the groove-seating edges of the ring body, which latter are the inner edges 32i of the inner-edge "beams" in the case of the external retaining ring, and the outer edges 32o of the outer edge beams in the case of the internal retaining ring.

The bevel angle may be the same as the bevel angle of known bevelled retaining rings 15° maximum), which is the safety angle designed to prevent the ring from sliding or being squeezed out of its groove under axial load. However, because the effective ring radial width is much larger and about twice that of the conventional tapered rings, tapered bevelled retaining rings have the capacity for a greater take-up than known bevelled rings, i.e., tapered retaining rings having a bevel along the groove-seating edges but completely devoid of the "beam" and connecting features.

WHAT WE CLAIM IS:—

1. A retaining ring for insertion in a circumferential groove provided in the surface of a carrier member, such as a shaft or a housing bore, to form a shoulder for the retention or location of a machine-part, the ring having an open-ended ring body comprising a plurality of alternately radially outwardly and radially inwardly directed portions each having a respective beam and common connecting arms extending divergently from and connecting the beams in series with one another, the beams of the radially from and connecting the beams in series with one another, the beams of the radially outwardly directed portions having radial widths which decrease progressively from a line radially bisecting the middle portion of the ring body and the connecting arms being arranged to be so deflected on expansion or compression of the ring body as to displace adjacent beams circumferentially of the ring body.

2. A retaining ring as claimed in claim 1, wherein the beams of the radially outwardly directed portions comprise short-length arcuate outer-edge portions of the ring body, divergent ring-body arm portions extend inwardly from the outer edge portions, the beams of the radially inwardly directed portions comprise short-length arcuate inner-edge portions of the ring body, the inner edge portions are angularly displaced relative to the outer-edge portions, divergent ring-body arm portions extend outwardly from the inner edge portions, and the divergent arm portions connect each outer-edge portion to facing ends of each two adjacent inner-edge portions and each inner-edge portion to facing ends of each two adjacent outer-edge portions.

3. A retaining ring as claimed in either claim 1 or claim 2, wherein the ring is adapted as an external ring to seat along its effective inner-edge in an outwardly opening groove of a shaft.

4. A retaining ring as claimed in either claim 1 or claim 2, wherein the ring is adapted as an internal ring to seat along its effective outer-edge in an inwardly opening groove provided in a housing-bore surface.

5. A retaining ring as claimed in either claim 3 or claim 4, wherein the ring is provided along its effective groove-seating edge with a bevel to facilitate end-play being taken up by the ring, when inserted.

6. A retaining ring substantially as hereinbefore described with reference to

and as illustrated in Figs. 1 and 2 of the accompanying drawings.

7. A retaining ring substantially as hereinbefore described with reference to and as illustrated in Figs. 3 and 4 of the accompanying drawings.

8. A retaining ring as claimed in either claim 6 or claim 7 and substantially as hereinbefore described with reference to Fig. 5 of the accompanying drawings.

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1441467 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

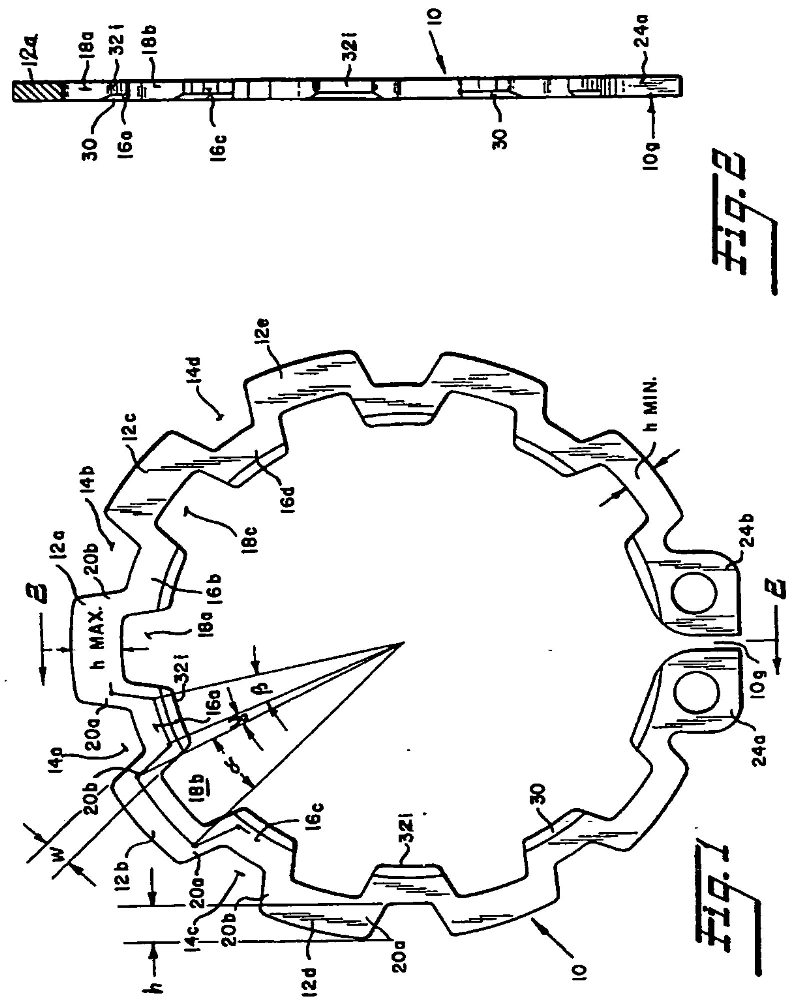


Fig. 2

Fig. 1

1441467 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

Fig.3

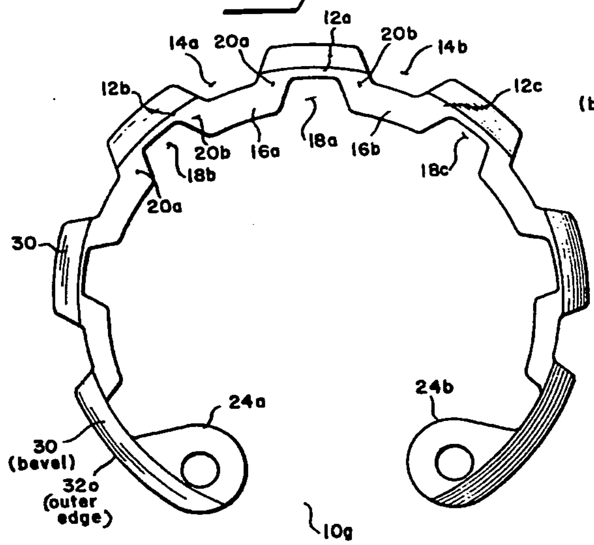
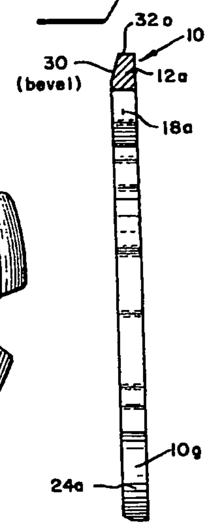


Fig.4



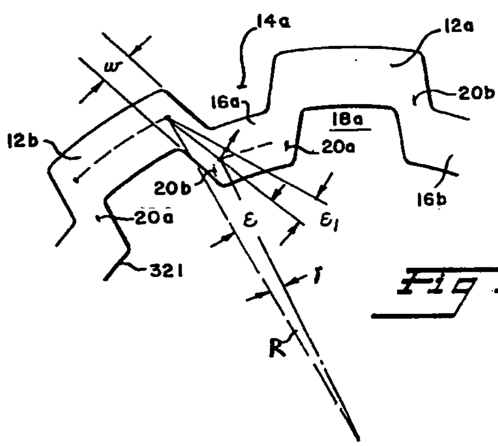


Fig 5